Connecticut River Atlantic Salmon Commission

Species Status Report

Prepared by the Shad Subcommittee of the Technical Committee

June 2015

American Shad (*Alosa sapidissima*)

1. Population status and management goal

Management goal: To restore and maintain a spawning shad population to its historic range in the Connecticut River basin and to provide and maintain sport and in-river commercial fisheries for the species.

The population is considered stable, but at reduced levels of abundance according to the Atlantic States Marine Fisheries Commission's (ASMFC) American Shad Benchmark Stock Assessment and the CRASC American Shad Management Plan objective of 1.5 to 2.0 million fish entering the river mouth annually (ASMFC 2007; CRASC 1992). Fish passage counts are the primary metric used to gauge abundance and trends over time, in spite of the many factors which can influence fish passage rates within and among years. Subsampling of the annual run for length and weight by sex, age structure, and spawning history are also monitored primarily at Holyoke Dam, by the Connecticut Department of Energy and Environmental Protection (CTDEEP). Declines in older age classes (> age-6) and in the proportion of repeat spawners are a management concern, as are low to absent adult return numbers upstream of dams with and without fishways, on both the main stem and tributaries.

2. Distribution

American shad distribution in the main stem river extends to the historic upstream natural barrier of Bellow Falls, VT at river kilometer (rkm) 280, requiring passage at Holyoke Dam, MA (rkm 139), Turners Falls Dam, MA (rkm 198), and Vernon Dam, VT (rkm 228)[Figure 1].

Although shad may be able to utilize (i.e. spawning) the main stem river up to Bellows Falls, abundances begin to decrease (with variability) at each upstream barrier encountered, with the most substantial decrease, occurring at the Turners Falls Dam fishway complex. Access to tributary habitat upstream of first barriers is affected by fishway designs and operations, and other factors that have been shown to be an issue to shad passage, one example being the design of Rainbow Dam Fishway on the Farmington River, CT. A map of current and future targeted American shad distribution is shown in Figure 1 along with barriers that have existing upstream passage fishways and those that do not.

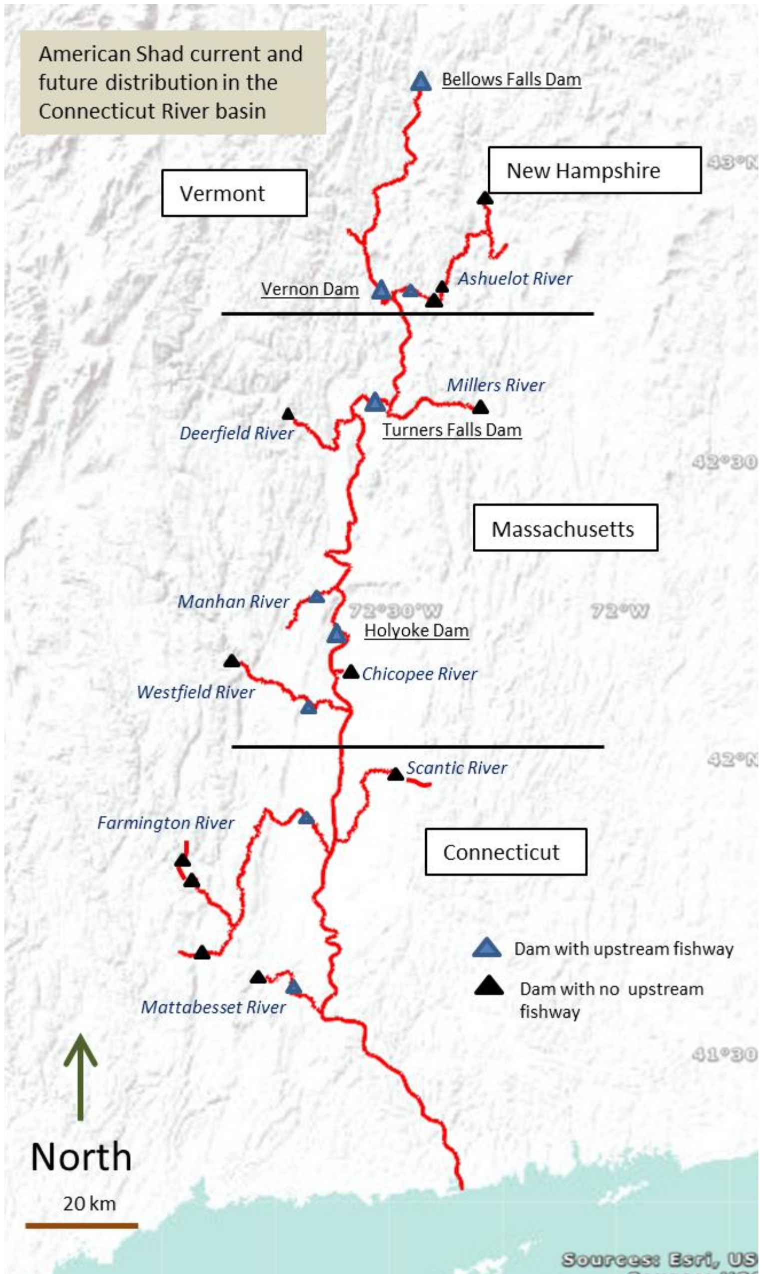

Figure 1. Current distribution of American shad in the Connecticut River basin based upon noted presence of upstream passage fishway (blue) and future targeted habitat in select tributaries upstream of unpassable barriers (black).

3. Data sources

A. Upstream Fish Passage Counts

State and Federal agency staff have reported count data for main stem and tributary fishways (Appendix 1). Counts at five passage facilities are reported for the period 1980-2014 (Figure 2). For the period 1980 to 2014, the Holyoke Fish Lift has passed an average of 313,000 shad annually. All facilities have shown declining trends starting after 1992 that persisted through

2009/2010. However, counts at all facilities except Rainbow Dam, have increased over the decadal average during the past three years.

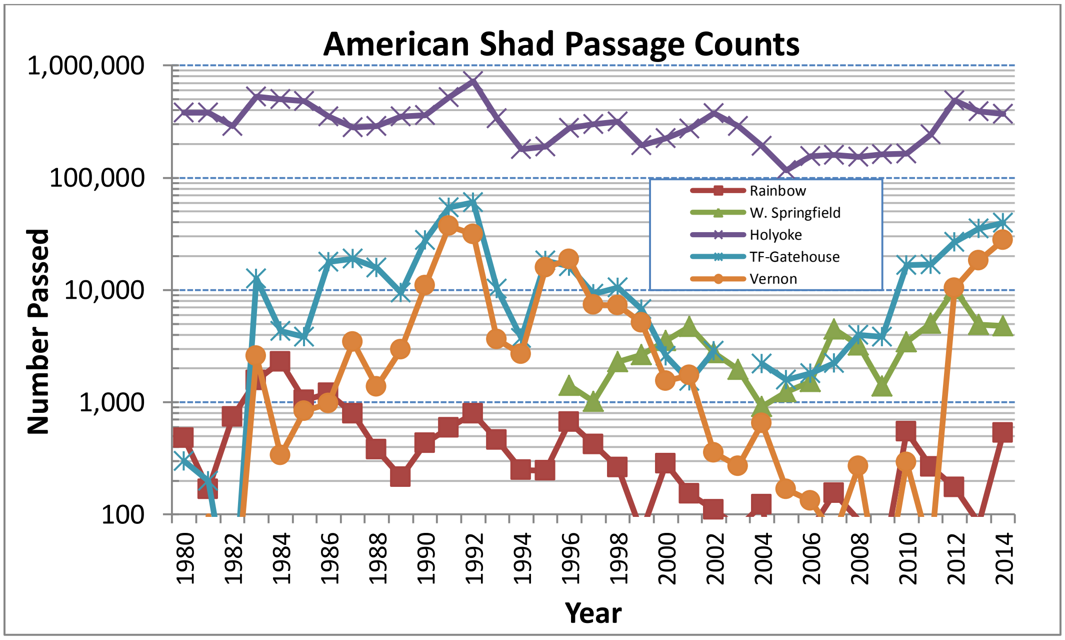

Figure 2. American shad fish passage counts for major Connecticut River basin fishways: Rainbow (Farmington River), W. Springfield (Westfield River), Holyoke Dam (Holyoke Fish Lift), TF-Gatehouse (final ladder at Turners Falls Dam), and Vernon Dam. Data are for 1980 through 2014 and are shown on a logarithmic scale. Counts are substantially influenced by within and between year, river discharge, dam operations, fishway modifications, fishway issues, water temperature and other variables.

B. Juvenile Index of Abundance

The Connecticut Department of Energy and Environmental Protection (CTDEEP) has conducted annual monitoring of juvenile American shad abundance using seine gear at seven established main stem shore locations downstream of Holyoke Dam since 1978. Using standardized approaches, the survey goal is to detect relative changes in juvenile recruitment or production for a given year. The data indicate highly variable abundance values over the years (Figure 3) and appeared not to be linked with subsequent adult abundance since the mid-1980s.

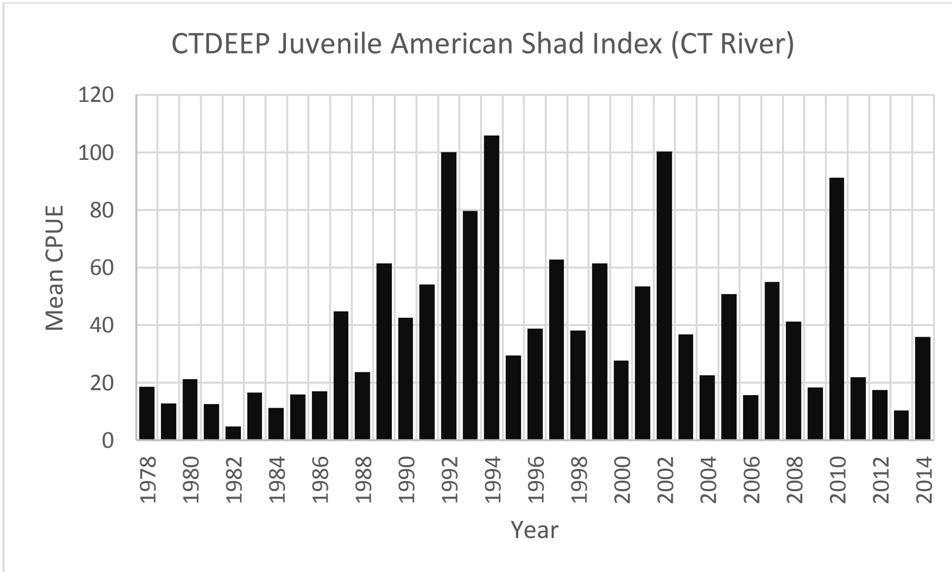

Figure 3. The CTDEEP Marine Fisheries Division's annual mean catch per effort value of juvenile American shad from seine surveys conducted July through October downstream of Holyoke Dam at seven sites on the main stem.

C. Commercial and Recreational Harvest

Commercial fishing occurs only downstream of Hartford, CT with the CTDEEP monitoring commercial landings since 1976 (Figure 4). Steady declines in landings have occurred over the years but weak demand and failure to recruit younger fishers may play a strong role along with stock size.

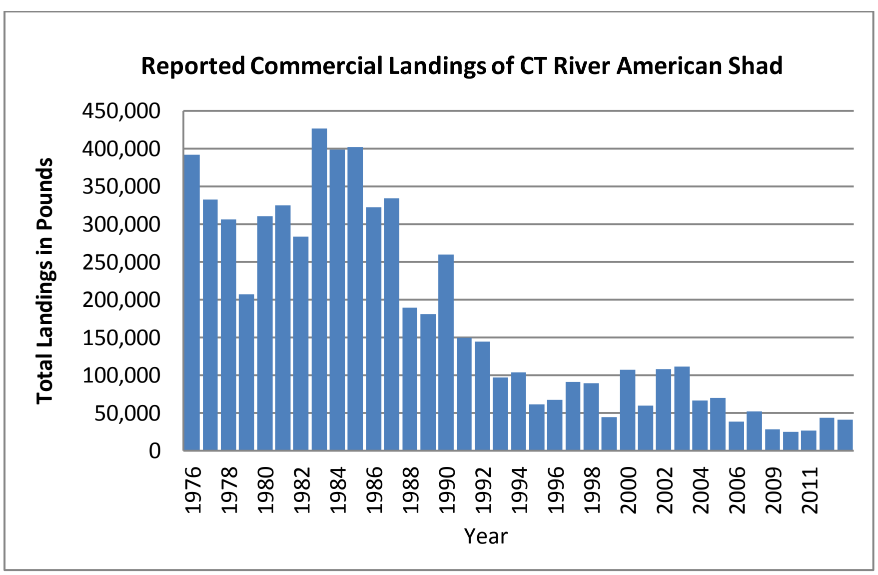

Figure 4. Commercial landings data for Connecticut River American shad, in-river fishery, from CTDEEP, 1976-2013.

Recreational landing data has also been collected by the CTDEEP since 1976. These data show a sharp decline in catches since the early 1990s (Figure 5). Creel surveys by CTDEEP were not conducted for 1998, 1999, 2001-2004, 2006-2009, and 2011-2015. Recreational landings are estimated for those years of no surveys by CTDEEP.

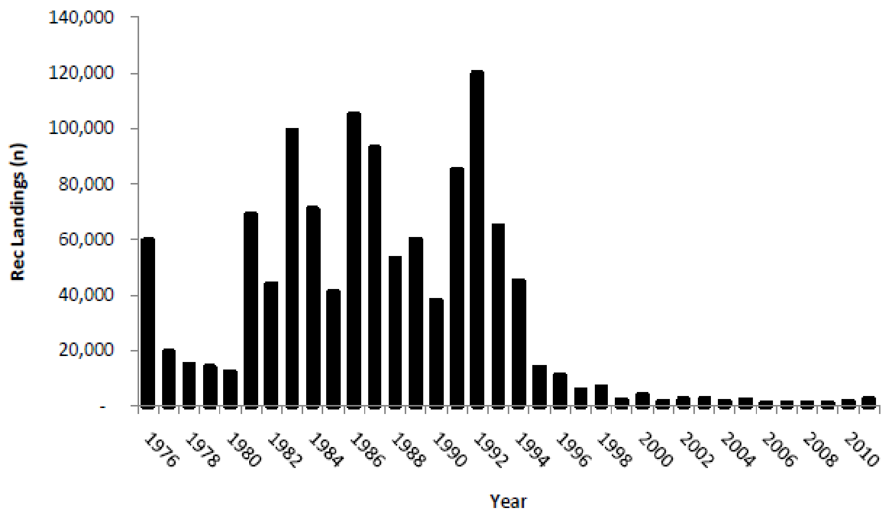

Figure 5. Estimated number of recreationally harvested American shad, downstream of Holyoke MA, from CTDEEP, 1976-2011.

The ASMFC required states to submit Sustainability Plans by 2012, for review and approval, "*that demonstrate their stock could support a commercial and/or recreational fishery that will not diminish the future stock reproduction and recruitment*." The CTDEEP submitted the required Plan in 2012 that was approved in 2013, allowing for the continuation of fisheries on this stock, with additional monitoring and management trigger mechanisms (CTDEEP 2012). The Commonwealth of Massachusetts used the CTDEEP Plan to obtain approval for continued recreational fishery harvest in its Connecticut River basin jurisdiction. Both the state of New Hamsphire and Vermont did not have approved plans and defaulted, without disagreement, to a catch-and-release only recreational fishery. Appendix 2 lists a summary of state fishery regulations for American shad.

4. Progress of Restoration

The Connecticut River Atlantic Salmon Commission's (CRASC) Management Plan for Connecticut River American Shad includes the objective of 1.5 to 2.0 million shad entering the river mouth annually. Not since the estimated 1983 and 1992 runs of 1.5 and 1.6 million fish respectively, has that objective been considered attained, since 1967. In 2005, following fishway improvements and other operational changes at Holyoke Dam as part of FERC relicensing, the river population estimate that relied on pre-license passage conditions and operations at that dam as well as other variables that are believed to be dated has not been possible. However, recent analyses of shad radio tagged at the river mouth in 2011 and 2012, has provided an estimate of 48% of the run passing (2 year average) the Holyoke Dam using preliminary study results (Kenneth Sprankle, USFWS, personal communication).

The Holyoke Fish Lift provides one of the best long-term indicators of trends in shad abundance, but is subject to many variables that influence fish passage rates. The average number of adults passed from 1976 to 2014 is 306,000 shad. Using the CRASC Plan passage lowest rate of 40% passage (40-60% passage identified for upstream dams, no target for Holyoke at this time), and the lower bound of the restoration target (1.5 million fish entering), the lower-bound run objective (600,000 Holyoke passed) was only achieved in 1992, with 721,000 passing Holyoke Dam. Progressing upstream, from Holyoke Dam, the CRASC Plan maintains an objective of 40-60% passage at each successive upstream barrier. Using the lower range values again, 600,000 shad passed at Holyoke with 40% passage at Turners Falls Dam fishways would translate to 240,000 passed at that barrier. The highest number of shad passed upstream of Turners Falls Dam was 60,089 (1992). The percentage rate passed upstream of Turners Falls Dam relative to Holyoke Dam passage has never exceeded 11%, falling well below the lower 40% range of the passage target. Once again using the lowest range of the population goal and the lowest fishway passage rate (40%), the Vernon Dam fishway would have an (5-year averaged) annual target of >96,000 shad passed. This target has never been achieved with the closest annual value being 37,000 (1992). Although the Vernon Dam fishway has shown highly variable passage rates since starting in 1981, in the past three years (2012-2014) the Vernon passage rate relative to Turners Falls passage, has averaged 53%, within the management plan objective.

In spite of these reported numbers being below restoration target values, the shad run has been extended up to Bellow Falls Dam, VT, with tens of thousands of adult fish in areas where they were once denied access for over 180 years upstream of Turners Falls Dam (over 82 rkm gained in main stem habitat alone). These new fishways were completed at Turners Falls Dam in 1980 and then at Vernon Dam in 1981 (Appendix 1). Tributary access has been provided with this increased main stem access, as well as by tributary fishway facilities (Figure 1; Table 1). As a result, ecological benefits from adults and juveniles have occurred along with new recreational fishing opportunities in areas of historic habitat that had been previously blocked, most notably for the states of New Hampshire and Vermont.

5. Factors that affect population size and dynamics

A. Migratory Barriers

American shad were known to occur in abundance in the main stem river up to Bellow Falls Vermont, a distance of 280 rkm from the mouth (Figure 1). The species has potential access to all historic main stem habitat through the use of existing fishways (Table 1). In addition, American shad utilize tributaries in the basin which contain additional barriers that often prevent full historic access (Figure 1). In both instances, on main stem and tributaries, fishways have been shown to pass shad to varying degrees of effectiveness, often based on very limited observational evidence and not rigorously designed evaluations. One of the most studied areas on shad passage is the Turners Falls Dam fishway complex, where the Conte Anadromous Fish

Research Center has documented behaviors and effects relative to fishway designs, fish attraction, retention, and passage, focused at Cabot Ladder and Gatehouse Ladder. Ultimately, most fishways that are in use have not been studied for fish performance on important variables that include attraction, retention, passage, and delay/timing which affect not only the numbers that are passed, but under what conditions they may or may not pass. It is not known to what extent reproduction and energy status may be affected and whether that may have population impacts at both the local reach (river dam segments) and larger scales. Also unknown is how fish passage performance affects the numbers of adult shad available for recreational fishing.

Table 1. Existing upstream fish passage facilities used by adult shad.

Main stem (rkm)	**Project/Dam**	**Upstream Fishway Design**	**Status**
139	Holyoke	Fish lift	Pending modifications driven by downstream passage requirements, evaluation studies planned for 2016
198	Turners Falls	Modified Ice Harbor and vertical slot	Long standing passage issues, study and modifications; Cabot Station Ladder, Spillway Ladder and Gatehouse Ladder (vertical slot), evaluation studies in 2015 (FERC relicensing)
228	Vernon	Modified Ice Harbor and vertical slot	Evaluation studies in 2015 (FERC relicensing)
280	Bellows Falls	Vertical slot	Historic upstream extent of distribution, with ladder in place, upstream passage is possible
Tributary (name)			
Mattabesset River	StanChem	Denil	First year operation 2013, not evaluated
Farmington River	Rainbow	Vertical slot	Long standing issues with shad passage, CTDEEP owned facility, new fish lift design pending, not evaluated
Westfield River	West Springfield	Denil	Not evaluated
Manhan River	Manhan	Denil	First year of operation 2014, not evaluated
Ashuelot River	Fiske Mill	Fish lift	Not evaluated, known issues with false attraction to tailwater

Downstream passage for adults and juveniles is dealt with often by a combination of approaches including reduced trash rack bar spacing at turbine intakes (often upper water column only), the use of gates with and without modifications, and the use of angled louvers to guide fish at facilities. As noted for upstream passage, downstream fishway evaluations are also limited with similar concerns regarding route selection, potential impacts (immediate or delayed), and actual delay in relation to available energy reserves. The limitations of these evaluations create management concerns with population level and stock structure implications.

Table 2. Existing downstream passage measures for adult and juvenile shad.

Main stem (rkm)	**Project/Dam**	**Design**	**Status**
139	Holyoke	Reduced trash rack spacing; canal full depth louver to fish pipe; modified weir at opened gate	Pending modifications installs in summer 2015 - deep water entrances, modified discharge flume, studies planned via FERC/Settlement
198	Turners Falls	For Canal only, reduced trash rack spacing; fish sluice operated via modified weir at opened gate (Cabot Station only)	Studies planned via FERC Relicensing, e.g., routes, timing, effects on juveniles and adults
210	Northfield Mountain Pump Storage	None in place	Studies planned via FERC Relicensing, e.g., routes, timing, entrainment effects, early and later life stages
228	Vernon	Reduced trash rack spacing, except units 9 &10; partial depth and length louver to fish pipe, and smaller fish bypass pipe inside of louver	Studies planned via FERC Relicensing, e.g., routes, timing, effects on juveniles and adults
Tributary			
Mattabesset River	StanChem	None, spill, no hydropower	
Farmington River	Rainbow	Reduced trash rack spacing, gate to fish passage pipe	Not evaluated
Westfield River	West Springfield	Gates next to canal are opened, downstream bypass system and Denil ladder in operation for fall	Not evaluated
Manhan River	Manhan	Denil ladder and fish passage pipe in use	Not evaluated
Ashuelot River	Fiske Mill	Fish bypass pipe	Not evaluated

B. Water Quality and Quantity

The Connecticut River American Shad Habitat Plan that was produced for the ASMFC includes more details on this topic (ASMFC 2014). Water quality and quantity concerns include, but are not limited to: water discharge fluctuations and regulation at hydropower facilities (e.g., timing, magnitude); minimum flows in bypassed reaches vs. power canals; intake and discharge of thermal waste water; elevated turbidity levels; non-point source releases of chemicals (e.g., urban and farm lands); and combined sewer overflow from wastewater plants. While a variety of anthropogenic factors likely impact sections of the Connecticut River, currently no available data suggests that degraded water quality limits total shad population size. However, planned studies in 2015 on FERC relicensings noted in Table 1, will help provide necessary data to begin to examine components (e.g., spawning behavior under different operations) of these question.

C. Land Use and In-river Activities

State and Federal laws are in place to protect, mitigate and or enhance riparian habitat and associated wetland habitats (e.g., Massachusetts Rivers Protection Act) to varying degrees in the four basin states. These regulatory measures have been used by all states to protect aquatic habitat in the basin. State and federal resource agencies rely on FERC hydropower relicensing process and Water Quality Certification (federal Clean Water Act) process to address larger scale river water users. States are authorized to issue Water Quality Certificates if they choose on federal actions, to ensure that these actions are in conformance with state water quality standards.

D. Climate Change
Climate change may impact the timing, frequency, and magnitude of river discharge and temperature regimes based upon available information. How these effects relate to fishery management and restoration measures include, but are not limited to, fish movement, passage, energetics/survival, fishway and hydropower operational schedules, and spawning success that should be studied, evaluated, monitored, and utilized by management agencies. In the marine environment, monitoring and studies on important variables (e.g., water temperatures, food sources, predators) should be also be undertaken given even weaker understandings in those habitats.

6. Priority factors for management

The best information available would suggest there are many factors that may act independently or interactively to influence population dynamics, restoration and management goals. The subcommittee considers three of the likeliest factors affecting Connecticut River American shad.

A. Dams and hydropower effects
The physical presence of a dam and its impacts for fishes may seem clear, but new information adds complexity with important potential concerns for delay at dams in both upstream and downstream directions for adults. As adult shad undertake their spawning migration on stored energy reserves, the implications for delay include reduced survival, reduced upstream reproductive potential, and reduced extent of upstream migration (Castro Santos and Letcher 2010). Other dam and hydropower concerns include, flow and habitat alterations, redirection of flow to canals and/or storage reservoirs, discharge locations from gates and gate types, and immediate or delayed effects from through turbine passage or bypass structures and their release location and designs (e.g., predators). The functionality of an upstream fishway is based on a set of prevailing conditions (natural and operational) for design that become compromised outside of design conditions.   Fishway entrances and attraction flow can be overcome by competing flows that reduce or eliminate the ability of fish to locate fishway entrance(s), thus passage is negatively impacted and ultimately eliminated under higher range discharge conditions (Figure 6).

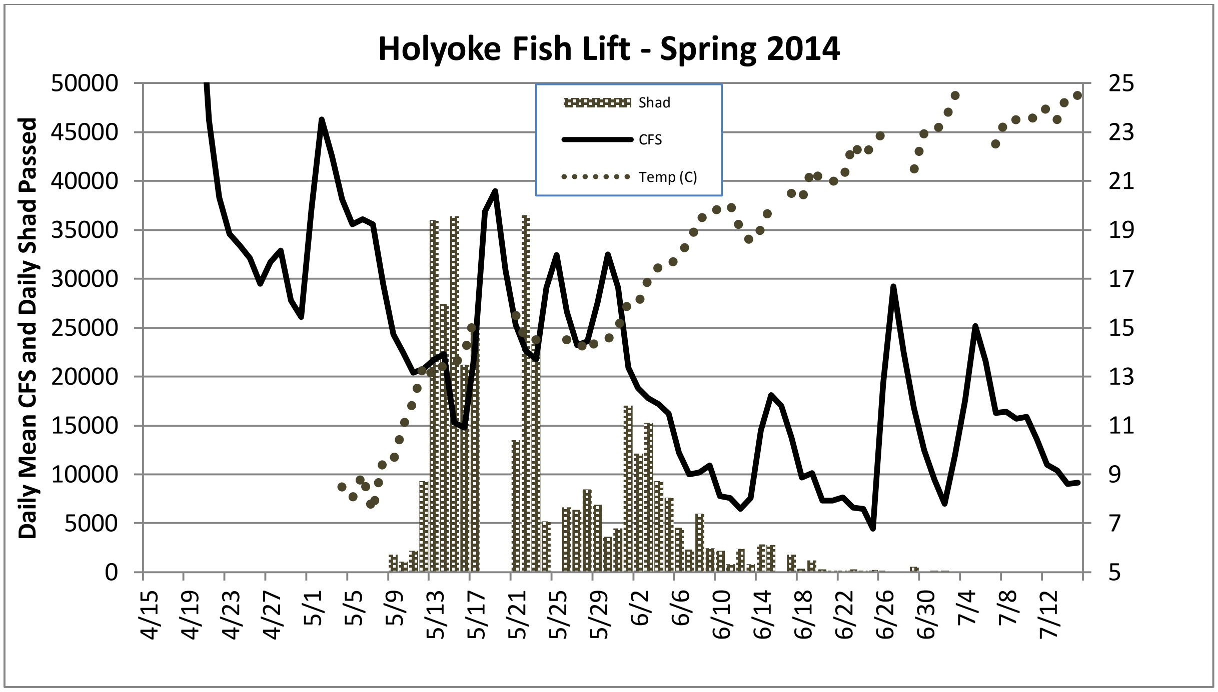

Figure 6. Upstream passage counts of American shad at Holyoke Dam in relation to river discharge and water temperature from spring of 2014.

B. Increased levels of mortality at sea

Environmental factors such as climate change or shifts in predator communities/abundance and anthropogenic factors like bycatch in marine commercial fisheries (e.g., small mesh trawl fisheries) of various life stages, must be better studied, understood and monitored for their contributions to marine mortality levels. Given the nature of these factors, CRASC likely will not have the appropriate means and tools to address all of these factors adequately, if at all (see section 6 below). However, given the scale of the observed shad run declines along the East Coast, an impact or combinations of impacts in the marine environment seems logical as a hypothesis.

C. Predation by striped bass

Successful fishery management measures have resulted in sustained, relatively high levels of abundance of the migratory stock of striped bass, which move into the Connecticut River in the spring with shad and river herring as a concentrated forage base. The mixed migratory stock may be having an increased impact on forage species like river herring and possibly shad that are considered to be conversely at “depressed” levels (Davis et al. 2012). Impacts from predation on shad are limited to a smaller proportion of the overall striped bass population in-river, based on the larger size of shad. However, artificially created bottlenecks, like fishway entrances at dams or downstream fishway release sites remain a potential concern for impacts and require further investigation.

7. Possible CRASC strategies

In order to achieve our Plan goal *"To restore and maintain a spawning shad population to its historic range in the Connecticut River basin and to provide and maintain sport and in-river commercial fisheries for the specie*s," we propose the following:

A. Gather statistically valid management information for status and trends
   i. monitor fish passage counts and maintain databases for all fishways
   ii. monitor age structure, repeat spawner component and other biological parameters
   iii. monitor juvenile production
   iv. monitor in-river commercial and recreational fishing

B. Conduct restoration actions
   i. trap and transport of pre-spawn adults, into vacant or limited use accessible habitat or soon to be accessible habitat
   ii. allow natural recolonization, after barrier removal and or fishway installation
   iii. coordinate with regional Fishery Management Councils to identify and address bycatch impacts

C. Assess, improve, and provide access to habitat
   i. develop an aquatic habitat assessment for use in both management and research activities
   ii. engage in habitat restoration projects to improve diadromous fish habitat within the basin.
   iii. Identify passage priorities that benefit shad and other species in the context of quantity and quality of blocked habitat and expected population response

D. Evaluate and improve fish passage
   i. Conduct fishway inspections at regular intervals (pre-season, in season, post season) to ensure operations are to design specifications
   ii. Develop site specific visual fishway inspection aids and protocols to identify issues by non-technical staff between formal inspections
   iii. Implement fish passage projects (dam removal or fishway construction) to re-connect upstream fish habitat with existing runs of fish.
   iv. Participate in all FERC relicensing and other processes that impact barriers to species and habitat targeted by CRASC
   v. Conduct fishway evaluation studies for upstream and downstream passage of all life stages in order to provide design and operational recommendations with specific performance considerations

E. Research and other informational needs (all areas)
   i. Develop a shad population model for the basin using new data, apply to management considerations and for related regulatory measures, such as FERC

relicensings, on main stem Connecticut River [*initiated in 2015 by NOAA, CRASC engaged*]

ii. Study of indeterminate fecundity and batch spawning of shad to aid in population model [*funded for 2015 by NOAA Woods Hole, CRASC engaged*]

iii. Study of shad physiology and energetics to aid in population model [*funded for 2015-17 by USFWS/NOAA/USGS, CRASC engaged*]

iv. Determine contributions of progeny from different temporal components of the run (run timing) and spatial reaches of the basin and in relation to adult numbers

v. Extent of interaction and natal origin of by-catch (sub-adults) in small mesh marine fisheries off East Coast

vi. Better quantify the role and contribution of juvenile shad life stages to river ecosystem

F. Participate in all relevant planning, management/research efforts and forums

i. Update 1992 Shad Management Plan, expand management topics of importance, biological stock components, fisheries, ecological (e.g., juveniles), including an Action Plan.

ii. Provide guidance on shad population model parameters and values, examine sensitivity and responses of selected parameters to aid in determining best management approaches to achieve restoration objectives.

iii. CRASC staff continued participation on the ASMFC Shad and River Herring Technical Committee

8. Main challenges to achieving these strategies

A. Staff limitations: As CRASC relies heavily upon effort from cooperating state agencies, there are obvious limitations in staff size, time, and training.

B. Resources: Limited equipment as well as funds to repair and replace broken equipment or pursue new tasks and studies identified by CRASC.

C. Capabilities: Several of the strategies identified in Item 6 are either outside the abilities or responsibilities of CRASC agencies. As in the past, CRASC will need to collaborate with federal and academic researchers (e.g., Conte Anadromous Laboratory) to overcome this issue.

9. Actionable CRASC priorities

- The Technical Committee and its sub-committee has provided a list of strategies to promote the restoration of shad but it lacks the resources to accomplish them all. The CRASC should provide the Technical Committee with guidance on prioritizing these strategies.

- It may be unclear what agencies should be involved with which strategies and which agency should take the lead on which strategies. The CRASC should provide guidance on these questions.
- There will be a list of strategies that will not be able to be pursued due to lack of resources. The CRASC should consider how to secure additional resources to accomplish these strategies.
- Most CRASC member agencies are not research agencies and therefore are not in a position to directly address the research needs listed in this document. However, many Commissioners control funds that can be directed toward researchers or sit on boards and associations that provide research funds. Whenever an opportunity arises, Commissioners should promote the research needs listed in this document.

A. Sub-Committee recommended priorities (1-3 years)

1. **Maintain existing monitoring programs.** *Purpose* - provide time-series data of management importance for status and trends. Both fishery independent and dependent programs for assessment purposes include fishway counts, age/size/sex structure of run (fishways/commercial/agency), commercial landings (recreational intermittent), juvenile production surveys, and other long-term monitoring programs providing time-series data for analyses. *CRASC Role* – staff time and resources to maintain activities.
2. **Development of an American shad population model**, **using new data**.
   Purpose – to provide agencies with a scientifically developed tool for considering, evaluating, proposing new management and restoration measures as well as understanding responses to variables on metrics of interest (adult returns and stock structure). With FERC relicensing of five main stem projects underway, the model may be a powerful tool for protection, mitigation, and enhancement recommendations from the agencies and CRASC. As an example, the model may be a key tool for development of passage and survival standards at hydroelectric facilities. The model design should allow for the incorporation of new study results and data. *CRASC Role* – CRASC staff initiated early concept design and engaged partners with a proposal developed by USGS Conte on shad energetics survival spawning study that was funded by USFWS starting in 2015 for 3 years. In addition the same group helped to coordinate the engagement of a NOAA shad modeling initiative to include the Connecticut River. Lastly, an additional data need was updated shad fecundity and batch spawning data will be provided through a NOAA funded study for 2015. CRASC staff will be closely engaged in all aspects of these activities.
3. **Continue agency participation in development of FERC Relicensing Studies related to American shad and development of additional monitoring measures outside of FERC project study areas (e.g., lower river reaches).**
   Purpose - maximize data on radio tagged American shad adults and juveniles starting in 2015. Resource agencies will use relicensing study results in relation to the Shad Population Model to compare outputs under different settings that management measures may influence. *CRASC Role* – staff support, assistance in obtaining needed funding.

4. **Update the Connecticut River American Shad Management Plan**.
   Purpose – The current Plan was approved in 1992 but there has been substantial new information for American shad in recent years. As the Shad Population Model effort has been recently been initiated, it has been determined the CRASC Shad Management Plan should be developed in concert with the model effort. An update of the Plan will be initiated in the summer of 2015. The updated Plan should be filed with FERC as a "comprehensive plan" in time to assist in the comprehensive development of all necessary protection, mitigation, and enhancement measures for new operational licenses. *CRASC Role* – staff support relative to the importance of this update and FERC relicensing process at the five main stem facilities.
5. **Publish results of 2011/2012 American Shad Migration and Survival Study.**
   Purpose – Results of the the USGS Conte and USFWS study be fully analyzed and developed. The findings will results in several peer reviewed publications that will increase the value and use of study findings. *CRASC Role* – staff time available for the Coordinator and USGS Research partners

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Appendix 1. Annual total American shad fish passage counts at Holyoke Dam, Turners Falls Dam and Vernon Dam and also the first dams/fishways on the Farmington River and Westfield River, 1980-2014.

Year	Holyoke Dam	Turners Falls Dam	Vernon Dam	Farmington River, Rainbow Dam	Westfield River, W. Springfield Dam
1980	380,000	**298**		480	
1981	380,000	200	**97**	167	
1982	290,000	11	9	737	
1983	530,000	12,705	2,597	1,565	
1984	500,000	4,333	335	2,289	
1985	480,000	3,855	833	1,042	
1986	350,000	17,858	982	1,206	
1987	270,000	18,959	3,459	792	
1988	290,000	15,787	1,370	378	
1989	350,000	9,511	2,953	215	
1990	360,000	27,908	10,894	432	
1991	520,000	54,656	37,197	591	
1992	720,000	60,089	31,155	793	
1993	340,000	10,221	3,652	460	
1994	170,000	3,729	2,681	250	
1995	190,000	18,369	15,771	246	
1996	280,000	16,192	18,844	668	**1,413**
1997	300,000	9,216	7,384	421	1,012
1998	320,000	10,527	7,289	262	2,292
1999	190,000	6,751	5,097	70	2,668
2000	225,000	2,590	1,548	283	3,558
2001	270,000	1,540	1,744	153	4,720
2002	370,000	2,870	356	110	2,762
2003	280,000		268	76	1,957
2004	192,000	2,192	653	123	913
2005	116,511	1,581	167	8	1,237
2006	155,000	1,810	133	73	1,534
2007	158,807	2,248	65	156	4,497
2008	156,492	4,000	271	89	3,212
2009	160,649	3,813	16	35	1,395
2010	164,439	16,422	290	548	3,449
2011	244,177	16,798	46	267	5,029
2012	490,431	26,727	10,386	174	10,300
2013	392,494	35,293	18,220	84	4,900
2014	370,506	39,914	27,706	536	4,787
Mean	313,043	13,499	6,308	451	3,244
SD	134,990	15,098	9,728	479	2,227
Low	116,511	11	9	8	913
High	720,000	60,089	37,197	2,289	10,300

First year of operation counts in bold and underlined

Appendix 2.

American shad fishing regulations for Connecticut, Massachusetts, New Hampshire, and Vermont for 2015.

State	Recreational	Commercial
Connecticut	Angling only, April 1 – June 30, six fish aggregate limit (American and hickory shad)	Gear (gill net), timing, area open to, and other restrictions apply, refer to CTDEEP. Season runs April 1 through June 15.
Massachusetts	Connecticut River - Angling only, January 1 – December 31, three fish limit	None
New Hampshire	Angling only, January 1 – October 15, catch and release only	None
Vermont	catch and release only	None